Revised: 10/30/03 Laboratory: _____ Inspector(s): _____ Date: _____

S___F___N/A___

TRIAXIAL COMPRESSIVE STRENGTH OF UNDRAINED ROCK CORE SPECIMENS
WITHOUT PORE PRESSURE MEASUREMENTS
ASTM D 2664-95

4. Apparatus:
4.1. Conform to 7.2 ___
4.2. Pressure-maintaining device maintain constant the desired lateral pressure ___
4.3. Chamber for containing membrane-encased specimen:
Between platens of tool steel with Rockwell hardness 58 HRC with bearing faces maintained within 0.001-in. (0.025 mm) flatness, one of which incorporates a spherical seat ___
Capable of maintaining constant high internal fluid pressure while transferring the axial load to the specimen ___
4.4. Measuring devices sensitive and accurate to 0.0001-in. (0.0025 mm) to measure specimen axial deformation ___
4.4.1. Electrical resistance strain gages applied directly to specimen oriented to measure axial (and optionally circumferential) deformation ___
4.4.1. If using strain gages, two axial gages placed vertically on opposite sides of specimen close to mid-height (and optionally another two gages placed circumferentially) ___
4.5. Flexible specimen membrane capable of preventing testing fluid from penetrating specimen without intrude significantly into surface irregularities under chamber pressure ___
4.5. Membrane long enough to extend well onto both platens and be just slightly smaller in diameter than the specimen ___

6. Test Specimens
6.1. Prepare and document test specimens according to ASTM D 4543 ___
6.2. Capable of monitoring and maintaining specimen moisture content prior to testing ___
8.1.2. To perform required Mohr circle analysis, a minimum of 3 specimens must be prepared and tested at different lateral pressures ___

7. Procedure:
7.1. After test assembly and chamber filling, adjust axial seating load upwards from approximately 25 lbf (110 N) while applying chamber pressure by monitoring to prevent axial deformation ___
7.2. Apply test axial load continuously to maintain close to constant strain rate (within 10%) ___
Select strain rate to fail similar specimen in unconfined test within 2 to 15 min. ___
Record axial loads and deformations (and optionally circumferential deformations) ___
After test completion, verify visually, and by specimen weights if necessary, that no testing fluid intruded the specimen ___

8. Calculation ___

9. Report ___

Data Sheet ___

S___F___N/A___

LABORATORY DETERMINATION OF PULSE VELOCITIES AND ULTRASONIC ELASTIC CONSTANTS OF ROCK
ASTM D 2845-00

6. Apparatus:
6.1. General, Impedance matched electronic components & shielded leads ___
Apparatus allowable voltage inputs not exceeded ___
6.2. Pulse generator unit:
Electronic pulse generator & if needed external voltage or power amplifiers ___
Voltage output in rectangular pulse or gated sine wave ___
Voltage output max. value after amplification at least 50 V into a 50-Ω impedance load ___
Variable pulse width, with range 1 to 10 μs ___
Pulse repetition rate fixed 60 repetitions/sec. ___; 20 to 100 rep./sec. desirable ___
Trigger-pulse output to trigger oscilloscope ___
Variable delay of main-pulse-output w/ respect to trigger-pulse output, w/ min. range 0 to 20 μs ___
6.3. Transducers, consist of a transmitter which converts electrical pulses into mechanical pulses & a receiver which converts mechanical pulses into electrical pulses ___
Piezoelectric recommended ___, Magnetostrictive suitable ___
Transmitter generate wavelengths at least 3 times the average grain size of the rock ___
6.3.1. Housed (metal) or unhoused transducer elements ___ (see 5.3.1. for possible improvements if housed)
6.3.2. If transducers housings used as load platens, they should be designed with thick face plates to assure uniform loading ___
6.4. Preamplifier – required if voltage output is relatively low or if the display & timing devices relatively insensitive ___
Frequency response drop no more than 2 dB over range from 5 kHz to 4 x resonance frequency of receiver ___
6.5. Display & timing unit:
Applied voltage pulse & voltage output displayed on cathode-ray oscilloscope w/ flat response between frequency of 5 kHz & 4 x resonance frequency of transducers ___
Dual beams or dual traces ___
Trigger by triggering pulse from pulse generator ___
Timing unit measure between 2 μs & 5 ms to accuracy of 1 part in 100 ___
Two alternative timing units – (1) electronic counter w/ provisions for time interval measurement or time-delay circuit (continuously variable-delay generator, or delayed-sweep feature on the oscilloscope ___
Travel-time measuring circuit calibrated periodically against required standards ___

7. Test Specimens:
7.1. Preparation
Care to minimize mechanical damage ___, Surface under transd. Plane (0.001 feeler gage not pass under straightedge ___, two opposite surfaces parallel to 0.005 in./un/ (0.1 mm/20mm) ___.
If pulse velocities measured at natural water content, make sure no loss of water ___
Oven-dried specimens not to exceed 150°F (66°C) ___
7.2. Limitations on dimensions:
Ratio of pulse-travel to min. lateral dimension NTE 5 ___
Travel dist. pulse through rock at least 10 x avg. grain size ___

8. Procedure ___

9. Calculation ___

10. Report ___

Data Sheet ___

S___F___N/A___

DIRECT TENSILE STRENGTH OF INTACT ROCK CORE SPECIMENS
ASTM D 2936-95 (01)

5. Apparatus
5.1. Loading device to apply & measure axial load of sufficient capacity to load @ rate required in paragraph 8.2 ____
5.2. Cylindrical end caps to be cemented to specimen ends ___
End cap diameters not < than dia. of spec. nor > than 0.0625-in. (1.6 mm) > than dia. of spec. ___
End cap thickness greater than 1 1/4-in. (32 mm) ___
Linkage system between end caps and lading device to transmit load through axis of specimen without torsion or bending ___
Length of linkages at each end at least 2 times diameter of end caps ___

6. Sampling:
6.1. Select from cores to represent valid average of type of rock under consideration ___

7. Test Specimens
7.1. Prepare and document specimen according to ASTM D 4543 ___
7.2. Capable of monitoring and maintaining specimen moisture content prior to testing ___

8. Procedure
8.1. Cement end caps to spec. using not > than 1/16-in. (1.6 mm) uniform thickness of cement ___
Verify parallel cemented end caps and adjust prior to cement hardening ___
8.2. Load specimen continuously without shock @ rate to fail within 5 to 15 min. ___

9. Calculation:
9.1. Calculate tensile strength by dividing max load by cross-sectional area to 35.0 kPa (5 psi) ___

10. Report ___

Data Sheet ___

S___F___N/A___

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMENS
ASTM D 2938-95

5. Apparatus
5.1. Load device capable of applying axial load to fail as required in paragraph 9.5 ___
5.2. Temperature measuring device, special limits-of-error thermocouples or platinum resistance thermometers (RTD's) w/ accuracy of ±1°C w/ resolution of 0.1°C ___
5.4. Platens, (primary or false) bearing faces have hardness not less than Rockwell HRC 58 ___
False platens (if applicable) 1/2 to 3/4-in. (12 to 20 mm) thick ___
Platen bearing faces maintained to plane within 0.001-in. (0.025 mm) ___
5.4.1. 1 platen spherically seated to load device with seat face diameter at least as large and not more than twice as large as specimen diameter and center of spherical seat coincident with specimen bearing face ___

7. Sampling:
7.1. Select cores to represent valid average of rock type under consideration ___

8. Test Specimens:
   a. Prepare and document test specimen according to ASTM D 4543 ___
   b. Capable of monitoring and maintaining specimen moisture content prior to testing ___
   c. To maintain moisture, seal specimen w/ membrane ___

9. Procedure:
   a. Check spherical seat mobility ___
   b. Clean load device specimen bearing faces & place specimen in place___
   c. When appropriate, install elevated-temp enclosure ___
   d. If test @ elevated temp, raise @ rate not > 2°C/min. until temp is reached ___
   e. Load specimen continuously and without shock at rate to fail within 2 to 15 min. ___
Record load at failure and elapsed time of loading ___

10. Calculation:
   a. Calculate compressive strength as follows:

$$\sigma = P/A$$

where:
σ = compressive strength
P = max load
A = cross sectional area

11. Report ___

Data Sheet ___

S___F___N/A___

ELASTIC MODULI OF INTACT ROCK CORE SPECIMENS IN UNIAXIAL COMPRESSION
ASTM D 3148-02

6. Apparatus:
6.1. Load device capable of applying axial load to fail as required in paragraph 9.5___
6.2. Elevated-temp enclosure (if required) ___
6.3. Temperature measuring device, special limits-of-error thermocouples or platinum resistance thermometers (RTD's) w/ accuracy of ±1°C w/ resolution of 0.1°C ___
6.4. Platens, (primary or false) bearing faces have hardness not less than Rockwell HRC 58 ___
Platen bearing surfaces maintained to plane within 0.015-in. (0.025 mm) ___
One platen spherically seated to load device with seat face diameter at least as large as and not more than twice as large as specimen diameter and center of spherical seat coincident with specimen bearing surface ___
6.5. Strain-deformation measuring devices, Strain resolution of 25 $X10^{-6}$, & accuracy w/in 2 % above 250 $X\ 10^{-6}$ strain, & accuracy & resolution w/in 5 $X\ 10^{-6}$ below 250 $X\ 10^{-6}$ ___
6.5.1. Axial strain determination, may be by electrical resistance strain gages, compressometers, LVDT's, ___
6.5.2. Lateral strain determination, may be by methods in 5.5.1 ___

9. Test Specimens:
9.1. Prepare and document test specimens according to ASTM D 4543 ___
9.2. Capable of monitoring and maintaining specimen moisture content prior to testing ___
9.3. To maintain moisture, seal specimen w/ membrane ___

10. Procedure:
10.1. Check spherical seat mobility ___
10.2. Clean load device specimen bearing faces & load specimen in place ___
10.3. When appropriate, install elevated-temp enclosure ___
10.4. If test @ elevated temp, raise @ rate not > 2°C/min. until temp is reached ___
10.5. Load specimen continuously and without shock at rate to fail within 5 to 15 min. ___

11. Calculation___

12. Report ___

Data Sheet ____

S___F___N/A___

SPLITTING TENSILE STRENGTH OF INTACT ROCK CORE SPECIMENS
ASTM D 3967-95 (01)

4. Apparatus:
4.1. Load device capable of applying axial load to fail as required in paragraph 7.3 ___
4.2. Bearing surfaces (primary or false platens) of steel w/ Rockwell hardness not < HRC 58 ___
4.2.1. Flat bearing blocks, surfaces maintained to plane within 0.015-in. (0.025 mm) ___
4.2.2. Curved bearing blocks (optional), radius of supplementary bearing plates such that contact arc with specimen is less than 15°, or width of contact less than specimen diameter/6 ___
4.2.3. Spherical seating, 1 bearing surface spherical seated, other plain rigid ___
4.2.4. Rigid seating, if not spherical, faces parallel to 0.005 mm/mm of block dia. ___
4.3. Bearing strips of 0.01 X spec dia thickness, or ≤ than 0.25-in. thick plywood ___

5. Sampling:
5.1. Select cores to represent valid average of rock type under consideration ___

6. Test specimens:
6.1. Dimensions, circular disk w/ thickness-to dia ratio 0.2 – 0.75 ___
Dia of spec at least 10 X > largest grain ___
6.2. No. of specimens, at least 10 ___
6.3. Circumferential surface smooth & straight to 0.50 mm (0.020 in.) ___
6.4. Ends parallel & right angles to longitudinal axis, ends not depart ⊥ > 5° ___
6.5. Dia to 0.25 mm (0.01 in.) by average of 3 measurements ___
6.6. Thickness to 0.25 mm (0.01 in.) by 3 measurements ___
6.7. Capable of monitoring and maintaining specimen moisture content prior to testing ___

7. Procedure:
7.1. Marking, vertical orientation mark w/ diametral line on each end ___
7.2. Position so diametral plane of the 2 lines line up w/ center of thrust of spherical bearing surface ___
7.3. Loading, load to fail w/in 1 – 10min. ___

8. Calculation:
8.1. Calculate splitting strength as follows:

$$\sigma_t = 2P/\pi LD$$

result expressed to appropriate No. significant figures (usually 3), where:
σ_t = splitting tensile strength, Mpa (psi),
P = max applied load, N (lb.),
L = thickness of spec, mm (in.), and
D = dia of spec, mm (in.).

9. Report ___

Data Sheet ____

S___F___N/A___

ROCK BOLT ANCHOR PULL TEST
ASTM D 4435-84 (98)

5. Apparatus:
5.1. Loading system, Hollow-center hydraulic ram & mounting/reaction frame (usable against uneven rock surfaces) w/ sufficient capacity to fail the anchor & have travel of at least 2 in. (50 mm) ___
Loading system force deviates no more than 5° from long axis of bolt ___
5.2. Load transducer, electronic load cell to measure load on rock bolt recommended ___
Cell w/ accuracy of ± 200 lbf (±890 N), including errors from excitation & readout system ___
Alternatively, pressure gage or electronic transducer if requirements met ___
5.3. Displacement transducer support, dial gage recommended w/ accuracy of ±0.001 in. (0.025 mm), resolution of 0.0005 in. (0.013 mm), & range of 2 in. (50 mm) ___
Mounted along axis of rock bolt within 5° ___
End of rock bolt, or pulling rod, smooth w/ counter-sink area approx. ¼ in. (6 mm) in dia. to accommodate measuring tip of dial gage ___
Other types disp. Transducers may be used if requirements met ___
5.4. Displacement transducer support, shall be supported from point no closer than 3 ft (0.9 m) if attached to same rock face ___,
Support sufficiently rigid that no deflection of instability occurs ___
5.5. Anchor systems, shall be from manufacturers std. stock ___, mechanical anchors to be inspected for defects ___
5.6. Rock bolt & accessories, rock bolt sufficient dia. & strength so elastic range not exceeded ___
5.7. Drilling equipment, same type equipment (drill & bits) as used during construction phase ___
5.8. Torque wrench (for expandable shell mechanical anchors), wrench w/ 20 % greater capacity than manufacturer's recommended torque ___
Accuracy at least ±3 % of full-scale reading, & resolution 0.01 in. (0.25 mm) ___
5.9. Borehole diameter measuring gage, accuracy ±0.02 in. (0.05 mm) & resolution 0.01 in. (0.25 mm) __

6. Procedure:
6.1. Drilling test hole:
6.1.1. Drilling test hole, use same procedure used during construction ___
Wash or blow borehole clean ___
6.1.2. Mechanical shell anchors, drill hole 1 ft (0.9 m) past end of anchor ___
Hole approx. 6 ft (1.8 m) in length ___
6.1.3. Inspect hole w/ flashlight, if more than 1/2 of bottom can't be seen, hole not straight enough ___
6.1.4. Measure hole dia. in 2 perpendicular directions at top & bottom of anchor (4 measurements) ___
6.2. Preparation of anchors, prepare same way as during construction (degreasing or rust removal) ___
6.3. Setting anchor:
11.1.1. Mechanical anchors – lightly lubricate downhole end of rock bolt & screw on anchor ___
Torque bolt to manufacturer's recommendation ___
11.1.2. Install cement grout or resin anchors to manufacturer's recommendation ___
11.2. Test method:
11.2.1. Tests performed in intentioned bolts ___
11.2.2. At least ½ test, perform 3 loading & unloading cycles to check for pre-failure anchor movement __
Apply load w/hydraulic ram in cycles to ¼, ½, & ¾ of est. failure load ___
11.2.3. Load smoothly & rapidly ___
11.2.4. After 3rd cycle, pull bolt to failure in the same increments used in last cycle or 500 lbf (2.2 kN) increments whichever is less ___
11.2.5. Non-cycled bolts to failure in 20 equal load increment or 500 lbf (2.2 kN) whichever is less ___
11.2.6. Record displacement & load after each pressure increment or decrement ___
11.2.7. Failure is peak load or total deflection of 0.5 in. (12.5 mm) ___
11.2.8. Pull bolt 0.5 in. (12.5 mm) beyond failure recording load every 0.05 in. (1 mm) ___
12. Calculation ___
13. Report ___

Data Sheet ____

S___F___N/A___

PREPARING ROCK CORE SPECIMENS AND DETERMINING
DIMENSIONAL AND SHAPE TOLERANCES
ASTM D 4543-85 (91), RTH 103

4. Specimens:
4.1. Specimens right circular cylinders ___
4.2. L/D ratio 2.0 – 2.5, dia. not < 1 7/8 in. (47 mm) ___
4.3. Sides smooth & free of irregularities, straight to w/in 0.020 in. (0.50 mm) ___
4.4. Ends parallel to each other & right angles to longitudinal axis ___
Ends ground or lapped flat not to exceed 0.001 in. (0.025 mm) ___

5. Procedure:
5.1. Determine deviation from straightness by procedure A or B, as follows:
5.1.1. Proc A, roll spec. on flat surface, measure max gap w/ feeler gage ___
If gap > 0.020 in. (0.50 mm), spec. does not meet tolerance ___
5.1.2. Proc B, Place spec. on machinist quality V-block (long enough so spec. not extend ends ___
5.1.2.1. Place dial gage (0.001 in. (.025 mm) in contact w/ top of spec. (Fig 1) ___
Read dial from 1 end to other ___
5.1.2.2. Max & min rdgs & calculate difference, Δ_0 ___
Repeat by rotating spec 120°, Δ_{120} & Δ_{240} ___, max value of 3 < 0.020 in. (0.50 mm) ___
5.2. Check flatness by Proc A or B ___
5.2.1. Proc A – Setup as in Fig. 2 ___
5.2.1.1. Move across a dia. of the spec. end ___
5.2.1.2. Dial rdg every 1/8 in. (3 mm) ___
5.2.1.3. Plot rdgs, draw curve, flatness tolerance met when curve not depart from best-fit straight line > 0.001 in. (0.025 mm) ___
5.2.1.4. Rotate 90° & repeat, then repeat on other end ___
5.2.2. Proc B – Set spec upright on smooth plane to 0.005 in. (13 μm) ___
5.2.2.1. Place dial tip in contact w/ top of spec w/dial readable to 0.0001 in. (2.5 μm) ___
5.2.2.2. Move dial tip across top of spec @ least 3 different diameters ___
5.2.2.3. Flatness tolerance met if max & min rdgs < 0.0015 in. (38 μm) ___
5.3. Ends not depart from ⊥ > 0.25° ___; Check tolerance using Proc A or B as follows:
5.3.1. Proc A - Calculate difference between max & min rdgs on Dia. 1, Δ_1 & for Dia. 2, Δ_2 ___
Perpendicularity tolerance met when:
Δ_I /d & Δ_I' /d = 0.0043; where: I = 1 or 2, and d = diameter
5.3.2. Proc B – Set spec upright on smooth plane to 0.005 in. (13 μm) ___
5.3.2.1. Place base of sq on test surface & in contact w/ bot of spec ___
5.3.2.2. Rotate spec until max gap found, measure gap w/ feeler gage ___
5.3.2.3. ⊥ met if gap , Δ, divided by Length, L, < 1 part in 230 ($\Delta/L \leq 1/230 = 0.0043$ ___
5.3.2.4. Repeat on other end of spec, unless ends were checked in 5.2.2 ___
5.5. 5.6. Get dia. to 0.01 in. (0.25 mm) by averaging 2 diameters @ right angles ___
Length to 0.01 in. (0.25 mm) @ centers of end faces ___
5.9. Moisture condition noted ___

6. Report ___

Data Sheet ____

S___F___N/A___

SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS
ASTM D 4644-87 (98)

5. Apparatus:
5.1. Slake durability device, wet bath tumbling device including water container, tumbling drum, rotation motor ___
Drum(s) cylindrical surface of 2.00 mm (No. 10) square-mesh, woven-wire cloth not torn, separated, or stretched ___
Drum(s) cylindrical in shape, diameter 140 mm (5.5-in.), length 100 mm (3.9-in.) ___
Drum(s) ends rigid plates, one removable, without extraneous supports or projections ___
Drum(s) capable of withstanding 110°C (230°F) ___
Trough(s) to support drum(s) horizontally allowing free rotation ___
Trough allows filling with water to 20 mm (0.8-in.) below drum axis allowing minimum of 40 mm (1.6-in.) clearance below drum mesh ___
Drum(s) rotated for 10 min. at 20 rpm constant to within 1 rpm without radial jarring of drum and contents ___
5.2. Drying oven, maintain temp 110 ± 5°C (230 ± 9°F) ___
5.3. Balance, sensitive to 1 g w/ capacity of 2000 g ___
5.4. Miscellaneous apparatus, including a brush ___
5.5. Distilled water ___

6. Test Specimen:
6.1. 10 representative, intact, roughly equidimensional fragments of 40 to 60 g each ___
Total specimen 450 to 550 g ___
6.2. Sample maintained at natural moisture conditions prior to testing ___

7. Procedure:
7.1. Weigh drum w/ specimen fragments, record weight, calculate natural water content ___
Dry 16 hr (or to constant mass) in drum in oven, cool 20 min., weigh, record, determine moisture content ___
7.2. Mount drum in trough, fill trough with distilled water at room temperature to 20 mm (0.8-in.) below drum axis ___
Immediately begin rotation at 20 rpm for period of 10 min., record water temperature ___
7.3. Immediately remove drum from trough and water, dry drum containing contents 16 hr (or to constant mass) ___
7.4. Weigh drum & spl for 2nd cycle, repeat 7.2 & 7.3 & weigh for final mass ___

8. Calculation ___

9. Report:
9.1.1. Description of material and origin ___
9.1.2. Second cycle slake durability index to nearest 0.1% ___
9.1.3. Range and average values of trough water temperatures ___
9.1.4. Original natural water content ___
9.1.5. Description of appearance of fragments remaining in drum after second cycle ___

Data Sheet ____

S___F___N/A___

DURABILITY OF ROCK FOR EROSION CONTROL UNDER
FREEZING AND THAWING
ASTM D 5312-92 (97)
RESISTANCE OF ROCK TO FREEZING AND THAWING
CRD-C 144-92

4. Apparatus:
4.1. Circular diamond saw, 14-in. dia., capable of sawing rock of type required in ASTM D 5121 ___
4.2. Freeze-thaw chamber or home freezer:
4.2.1. Timer-controlled designed for timed cycling 16 hr. freezing at –18 ± 2.5°C (0 ± 5°F) followed by minimum of 8 hr. thaw at 32 ± 2.5°C (90 ± 5°F) daily ___
4.2.2. Optionally, std. chest type freezer capable of reaching minimum temps in 4.2.1. ___
4.3. Oven (if 4.2.2. used), capable of holding test specimen & container & maintain constant temp of 32 ± 2.5°C (90 ± 5°F) for the 3 cycles ___, (CRD-C 144, 3.6.) 37.8 ± 5.6°C (100 ± 10°F) ___
4.4. Oven, 110 ± 5°C (230 ± 9°F) ___
4.5. Containers, stainless steel or PVC ___
4.6. Balance, readable to 0.1 % of total mass ___
4.7. Camera ___
4.8. Stereomicroscope, or other suitable device, at least 20x magnification ___

5. Special solutions:
5.1. 0.5 % isopropyl alcohol/water solution ___

7. Preparation of test specimen
7.1 Saw specimens in accordance with ASTM D 5121 ___
Each spec. (64 ± 6 mm) (2.5 ± 0.25 in.) thick) normal to bedding or potential planes of weakness___
(CRD-C 144, 4.1.) Each spec. (51 ± 6 mm) (2.0 ± 0.25 in.) thick) ___
Slab not less than 125 mm (5 in.) on a side, excluding thickness ___
Separate spec. for each orientation of various planes of weakness unless planes can be intersected with one orientation ___

8. Procedure:
8.1. Examine each slab visually & microscopically (20x mag.) for bedding planes, microfractures, & other planes of weakness & their condition & describe in accordance with ASTM D 5121 ___
8.2. Label & photograph each spec. w/ color film ___
8.3. Dry in oven to constant mass at 110 ± 5°C (230 ± 9°F) ___, time between weighings min. 4 hr. ___
8.4. Place specimens sawed side down on scrap carpeting, add alcohol/water to cover specimens, stand min. 12 hr. ___, (CRD-C 144, 6.2.) Cover so depth of solution over upper surface of specimen is 19 ± 6 mm (3/4 ± 1/4 in.) ___
8.5. Decant liquid so scrap carpeting just immersed ___
8.6. Place in freeze-thaw chamber/freezer at -18°C (0°F) 12 hr. ___
Place in temp 32°C (90°F) for 8 – 12 hr. ___
8.7. Repeat freezing & thawing for required No. of cycles rounded to nearest 5 cycles of the geographic area ___
8.8. Examine specimen every few days for changes & photo as needed ___
6.3. (CRD-C 144) Immersed specimens stored 22.8 ± 1.7°C (73 ± 3°F) for 48 hr., put in freezer 16 ± ½ hr., remove from freezer, put in oven at 37.8 ± 5.6°C (100 ± 10°F) for 16 ± ½ hr. ___
7.1. (CRD-C 144) Additional cycles up to 20 ___,
After each 5 cycles pour solution off over No. 200 sieve, return + 200 to pan, add new solution___
6.6. (CRD-C 144) At end of test pour over No. 200, both remaining material caught on sieve & in pan dry in oven ___
Photo contents, determine mass of fragments w/ more than 25 % of initial dry mass ___
9. Calculation ___
10. Quantitative examination ___
11. Report ___

Data Sheet ____

S___F___N/A___

DURABILITY OF ROCK FOR EROSION CONTROL UNDER
WETTING AND DRYING
ASTM D 5313-92 (97)
RESISTANCE OF ROCK TO WETTING AND DRYING
CRD-C 169-97

4. Apparatus:
4.1 Circular diamond saw, 14-in. dia., capable of sawing rock of type required in ASTM D 5121 ___
4.2 Containers, non-reactive & unbreakable to hold specimens immersed in potable water ___
4.3 Oven, 110 ± 5°C (230 ± 9°F) ___
4.4 Drying apparatus, infrared heat lamps (150 W) or oven set at 65 ± 5°C ___
4.5. Stereomicroscope, or other suitable device, at least 20x magnification ___
4.6. Balance, readable to 0.1 % of total mass ___
4.7. Camera ___

5. (CRD-C 169) 0.5 % isopropyl alcohol/water solution ___

6. Preparation of test specimens;
6.1 Saw specimens in accordance with ASTM D 5121 ___
Each spec. (64 ± 6 mm) (2.5 ± 0.25 in.) thick) normal to bedding or potential planes of weakness ___, (DRC-C 169, 6.1) 25 ± 6mm thick ___
Slab not less than 125 mm (5 in.) on a side, excluding thickness ___
Separate spec. for each orientation of various planes of weakness unless planes can be intersected with one orientation ___

7. Procedure:
7.1. Examine each slab visually & microscopically (20x mag.) for bedding planes, microfractures, & other planes of weakness & their condition & describe in accordance with ASTM D 5121 ___
7.2. Label & photograph each spec. w/ color film ___
7.3. Dry in oven to constant mass at 110 ± 5°C (230 ± 9°F) ___, time between weighings min. 4 hr. ___
7.4. Place specimens sawed side down in a container, on thin layer (6 mm) (1/4 in.)) of + No. 8 size sand, add potable water to cover specimens, stand min. 12 hr. ___, (CRD-C 169, 7.2) cover so depth of solution over upper surface of specimen is 25 ± 6mm ___
7.5. Decant water, place container under heat lamp w/ rock 40 – 50 cm (16 – 20 in.) from lamp ___
Alternatively, oven-dry @ 60 - 70°C (140 - 160°F) for min. of 6 hr. ___
At end of day repeat soak cycle overnight ___
7.6. Repeat setting & drying for 80 cycles ___
7.7. Examine every few days for changes & photo as needed ___
7.3. (CRD-C 169) Immersed specimens stored at 23 ± 2°C for 16 ± ½ hr., remove from solution, put in oven for 8 ± ½ hr. at 90 ± 5°C, remove and inspect ___
7.4. (CRD-C) Additional cycles up to 30 ___
After each 5 cycles pour solution off over No. 200 sieve, return + 200 to pan, add new solution ___
7.5. (CRD-C 169) At end of test pour over No. 200, both remaining material caught on sieve & in pan dry in oven ___
Photo contents, determine mass of fragments w/ more than 25 % of initial dry mass ___

8. Quantitative examination ___

9. Qualitative examination ___

10. Report ___

Data Sheet ____

S___F___N/A___

PERFORMING LABORATORY DIRECT SHEAR STRENGTH TESTS OF ROCK SPECIMENS UNDER CONSTANT NORMAL FORCE
ASTM D 5607-02

6. Apparatus:
6.1. Testing machine to apply normal & shear force ___
6.2. Shear box (Fig. 2) ___
6.3. Pressure-maintaining device ___
6.4. Specimen holding rings, aluminum or steel (Fig. 3) ___
6.5. Spacer plates:
6.5.1. Split spacer plates, plastic or suitable mat'l, of varying thicknesses ___
6.5.2. Non-split spacer plates, plastic or suitable mat'l, of varying thicknesses w/ circular or oval hole ___
6.6. Displacement measuring devices, LVDT's, dial indicators & DCDT's ___
Ranges of travel ± 13 mm (±0.5 in.) ___
Sensitivity for shear & normal displacement 0.025 mm (0.0001 in.) ___
6.7. Data acquisition equipment ___

7. Reagents & materials ___

8. Calibration & standardization:
8.1. Load monitoring devices calibrated in accordance w/ E 4 ___
8.2. Displacement measuring devices calibrated yearly ___

9. Test Specimens:
9.1.1. Intact specimens, minimize damage during coring, handling, & sawing ___
9.1.2. Specimen w/ single discontinuity ___
9.1.3. Size & shape, ht > thickness of shear zone ___
Cross-sectional dimension 10 X largest grain size ___
9.4. Moisture condition, keep @ natural moisture ___

10. Procedure:
10.1. Moisture condition, if water content required, determine in accordance w/ D2216 ___
10.2. Test specimens ___
10.3. Soaking of encapsulated specimen ___
10.4. Mounting into shear box ___
10.5. Mounting of displacement devices ___
10.6. Load application ___
10.7. Photographic record ___

11. Calculation ___

12. Report ___

Data Sheet ___

S___F___N/A___

DETERMINATION OF THE POINT LOAD STRENGTH INDEX OF ROCK
ASTM D 5731-95

5. Apparatus:
6.1. General, Loading system comprised of loading frame, platens, load measuring system, platen separation measuring system ___
6.2. Loading system ___
6.2.4. Truncated, conical platens (Fig. 2), the 60 ° cone & 5 mm radius hardened to HRC 58 ___
6.3. Load measuring system (load cell or hydraulic pressure gage) ___
6.4. Distance measuring system (vernier direct reading scale) ___
6.5. Miscellaneous, diamond saw, chisels, towels, marking pens, & plotting paper ___

7. Test Specimens:
7.1. Sampling, Core or block spec, get 10 spec, irregular-shape spec, get 20 ___
7.2. Dimensions, not < 30 mm and not > 85 mm ____
7.3. Size & shape, conform to Fig. 3 ___
7.4. Water content, determine water content in accordance w/ D 2216 ___
7.5.1. Marking, mark lines on spec for orientation of loading; reference measurements to these lines ___
7.5.2. Measuring, dimension measurements to be made three times and averaged ____

8. Procedure:
8.1. Diametrical test:
8.1.1. Specimen length to diameter ratio greater than 1.0 ____
8.2. Axial test:
8.2.1. Specimen length to diameter ratio between 1/3 and 1 ____
8.3. Block & irregular lump tests:
8.3.1. Specimens to be roughly prisms 30 to 85 mm in dimension ____
8.4. Anisotropic rock:
8.4.1. Rock that is shaley, bedded, schistose, or observably anisotropic, test in directions that will give greatest & least strength values parallel & normal to planes of anisotropy ___

9. Calculation:
9.1. Uncorrected point load strength index ___
9.2. Size correction factor ___
9.3. Mean value calculation ___
9.4. Point load strength anisotropy index ___
9.5. Estimation of compressive strength ___

10. Report ___

Data Sheet ____

S___F___N/A___

USING ROCK-MASS CLASSIFICATION SYSTEMS FOR ENGINEERING PURPOSES
ASTM D 5878-2000

5. Bases for classification:
5.1. Parameters for each classification system as follows:
5.1.1. Rock Mass Rating System (RMR), uniaxial compressive strength, rock quality designation (RQD), spacing of discontinuities, condition of discontinuities, ground water conditions, & orientation of discontinuities ___
5.1.2. Rock Structure Rating System (RSR), rock type plus rock strength, geologic structure, spacing of joints, orientation of joints, weathering of joints, & ground water inflow ___
5.1.3. Q-System or Norwegian Geotechnical Institute (NGI) System, rock quality designation (RQD), No. of joint sets, joint roughness, joint alteration, joint water-reduction factor, & stress-reduction factor ___
5.1.4. Unified Rock Classification System (URCS), degree of weathering, uniaxial compressive strength, discontinuities, unit weight ___
5.1.5. Rock Material Field Classification Procedure (RMFC), discrete rock-particle size, uniaxial compressive strength, joint orientation, joint-aperture width, geologic structure, seismic velocity, URCS rating, rock quality designation (RQD), mineralogy, porosity & voids, & hydraulic conductivity & transmissivity ___
5.1.6. New Austrian Tunneling Method (NATM), A: 1.stable 2.overbreaking; B: 1.friable 2.very friable 3.rolling/running; C: 1.rock bursting 2.squeezing 3.heavily squeezing 4.flowing 5.sweilling ___
5.1.7. Coal Mine Roof Rating (CMRR), Unit Ratings – shear strength of discontinuities (cohesion, roughness), intensity of discontinuities (spacing, persistence), number of discontinuity sets (compressive strength, moisture sensitivity); Roof Ratings – strong bed adjustment, unit contact adjustment, groundwater adjustment, & surcharge adjustment ___

6. Procedures for determining parameters:
6.1.1. RMR System, classification parameters (5) & their ratings (Sum ratings), rating adjustment for discontinuity orientations (Parameter No. 6) (RMR = adjusted sum), effect of discontinuity strike& dip in tunneling, adjustments for mining applications, input data ___
6.1.2. RSR System, schematic of the 6 parameters, rock type + strength; geologic structure (A), joint spacing & orientation (B), weathering of joints & ground water inflow (C); (RSR = A +B + C) ___
6.1.3. Q-System, RQD, joint set #, J_n, joint roughness #, J_r, joint alteration #, J_a, joint water reduction factor, J_w, stress reduction factor (SRF); ($Q = (RQD/J_n) \times (J_r/J_a) \times J_w/SRF$) ___
6.1.4. URCS, degree of weathering (A - E), estimated strength (A – E), discontinuities (A – E), unit weight (A – E), schematic of notation (results = AAAA thru EEEE) ___
6.1.5. RMFCP, schematic of procedure thru performance assessment, classification (description & definitions), rock unit, classification elements – (including rock mat'l properties, rock mass properties, & hydrogeologic properties), performance assessment – (performance objectives), erosion resistance, excavation characteristics, construction quality, fluid transmission, rock mass stability ___
6.1.6. NATM, rock mass types, calculation of support factor, & excavation class matrix for conventional tunneling ___
6.1.7. CMRR, CMRR calculation, immersion test, field data sheet, directions for field data sheet, cohesion-roughness rating, spacing-persistence rating, multiple discontinuity set adjustment, strength rating, moisture sensitivity rating, unit rating calculation sheet, roof rating calculation sheet, strong bed adjustment, unit contacts adjustment, groundwater adjustment, surcharge adjustment, & CMRR values ___

Data Sheet ___

S___F___N/A___

Method of Testing Stone for Expansive Breakdown on Soaking in Ethylene Glycol
CRD-C 148-69

3. Reagent
3.1 Ethylene glycol or glycerol (Note 1) ___

4. Apparatus
4.1. Container of sufficient size (glass, plastic) nonreactive with the reagent ___
4.2 Balance accurate to at least 0.1 % of weight of sample ___
4.3 Drying oven, 230 ± 9°F (110 ± 5°C) ___

5. Sample
5.1. Sample size, 11 ± 1 lb (5 ± 2 kg), pass 3-in sieve, retained ¾-in sieve ___

6. Preparation of samples
6.1. Sieve, crush, or break to requirements of 5.1 ___
Wash w/ distilled to remove dust, coatings, & chips ___
Weigh to at least 0.1 % of its weight & dry in oven to constant weight & record ___

7. Procedure ___
7.1 Place in container & immerse in reagent covering all particles to depth of at least ½ in (1 cm) ___
7.2 Intervals NTE 3 days remove spl from container & examine, note changes & photograph if significant ___
Normal test time is 15 days ___
7.3 At end of test, sample may be washed on ¾-in sieve (to remove reagent & remove fragments passing ¾-in sieve), + ¾-in material dried and weighed to requirements in 6.1 ___

8. Report
8.1. Report to include the following:
8.1.1. Identification & description of source material (type, amount, distribution & state of expansion of clay minerals) ___
8.1.2. Qualitative and, if obtained, quantitative data on effect of treatment on sample ___

Data Sheet ___